HISTORY AND DESCRIPTION

OF THE

STEAM-SHIP GREAT BRITAIN,

BUILT AT BRISTOL

FOR THE

GREAT WESTERN STEAM-SHIP COMPANY;

TO WHICH ARE ADDED, REMARKS

ON THE

Comparative Merits of Iron and Wood

AS

MATERIALS FOR SHIP-BUILDING.

BY CAPT. CLAXTON, R. N.

NEW YORK:
PUBLISHED BY J. SMITH HOMANS,
295 BROADWAY

1845.

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THE

STEAM-SHIP GREAT BRITAIN.

THIS splendid iron ship—the largest vessel we believe in the world—was launched, or rather floated off, from the dock at Bristol in which she was built, on the 19th of July, 1843, in the immediate presence of Prince Albert and a large concourse of noblemen and gentlemen, and families of the first distinction from nearly every quarter of the kingdom, as well as of many thousands of spectators belonging to that town, and congregated on the adjacent heights, and every available point of view on shore, or from vessels on the river. The untoward delays that afterwards arose in getting the vessel ready for sea, are already before the public. Every difficulty has happily been overcome; and as the vessel has already most satisfactorily solved the problem involved in the magnitude of her construction, and her peculiar mode of propulsion (from which a new era in ocean steam navigation will henceforth be dated), we have taken steps to gratify our readers by a more detailed account of the leviathan and her machinery, with statistics, illustrated by wood-cuts, presenting views of her hull, machinery, &c., so that an accurate idea of the whole may be attained at a glance.

General Description of the Great Britain.

The following are the dimensions of the ship :—

Length of keel	289	feet.
" from figure-head to taffrail	322	"
Extreme width	51	"
Depth of hold from upper or spar deck	32½	"
Burthen, by old measurement, about	3443	tons.
Power, 2 engines of 500 horse-power each	1000	
Boiler (square) 34 feet by 22 in height.		
Furnaces, 24—12 forward and 12 abaft.		
Stroke of piston	6	feet.
Displacement of water when drawing about 16 feet (or loaded), about	3000	tons.
Stowage for coal	1100	"
" goods additional about	1200	"
Will accommodate about	360	passengers
And dining accommodation for	380	"
Crew and firemen	350	persons.

The vessel is entirely built of iron, with the exception of the boarding of her decks and some of her cabin fittings and carved-work. Her model is somewhat peculiar, yet accordant with the

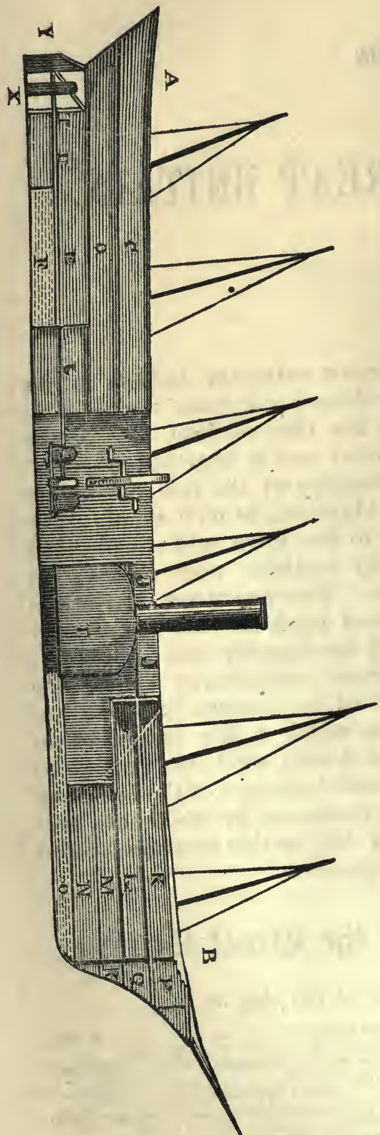


Fig. 1.*

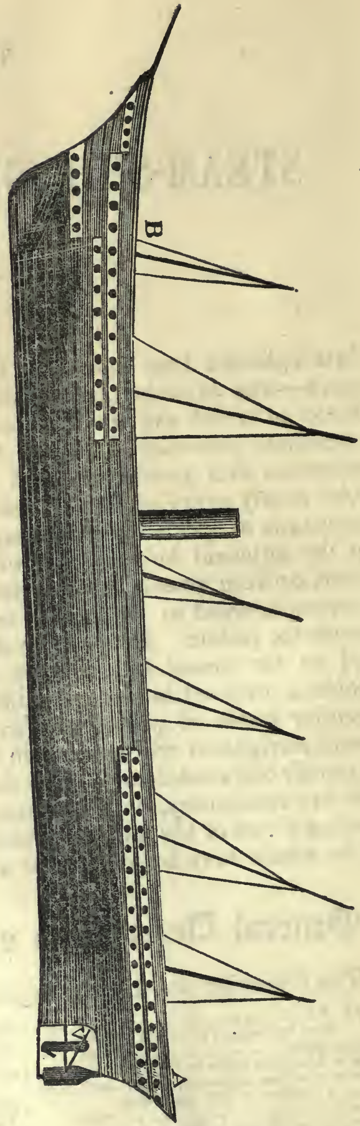


Fig. 2.*

taste (when she was built) of many nautical men, and the speed she has since attained, together with her good sea qualities, prove that their opinions were well founded. Her sides tumble, or fall in, a good deal towards the top deck, from about the middle of her length to the stern, giving her a man-of-war like appearance and a wholesome rotundity in the after body. Abreast of the boilers, which are forward of the longitudinal centre, her sides are rather flattish, but she has, after all abundance of bearings, for a steamer, and more aloft might have produced heavy rolling in a sea-way. Her bottom bearings are ample, and she is finely moulded with a sharp entrance, approaching to the plough form, and an equally fine run. Her upper works, like most of the Bristol ships, are plain, but substantial in finish. The hull is formed of iron plates, decreasing in thickness from the keel upwards, and angle iron ribs of great strength. The plates are not, however, so thick in proportion to her size as those of some iron vessels since constructed, particularly those built at North Birkenhead (for war purposes), but she is nevertheless a very strong ship, being bound securely by rods on the tension principle. The plates of her keel are from $\frac{3}{4}$-inch thick in the middle, to 1 inch at the ends, and all the plates under water are from $\frac{5}{8}$ths to $\frac{1}{2}$-inch at the top, except the upper plate which is $\frac{5}{8}$ths. She is chiefly clencher-built, and double riveted *at many points*. The ribs are 6 inches by $3\frac{1}{2}$, by $\frac{1}{2}$-inch thick at the bottom of the vessel, and 7-16ths at the top. Her rig is that of what may be called a six-masted schooner, with fore and aft sails, and lugger topsails, with the exception of the mainmast (the second from the bow), which will carry a square mainsail and a topsail over it. She has four decks, and the upper, or spar deck, is 308 feet in length. The engines are somewhat on the patent of Sir Mark Brunel, with the cylinders, in place of being upright, standing on an angle of about 60 degrees. The main shaft for the turning of the screw, and which is of great length and large diameter, was made at the Mersey Iron Works; and is itself a great curiosity.

On the spar deck there are eight skylights for the fore saloon, and one large light over the engine room. The under decks and apartments have borrowed lights from these, and also circular lights in the sides of the ship—the latter of plate glass an inch in thickness. The companions, or entrances from the deck, are fitted with doors on either side, so as always to have a weather and a lee door, the former of which may be closed during gales. The windlass is on a patent principle. The best bower anchor weighs about three tons, and its iron chain cable is of $2\frac{1}{2}$ inches diameter in the metal of the link. The bowsprit is proportionably short, owing to the great length of the vessel. The bow is

enriched with carved work: in the centre are the Royal Arms, surrounded by emblems of the arts and sciences of the empire, and (in illustration of the power and speed of the ship) representations of the thunderbolt of Jove and the caduceus of Mercury.

Perhaps the most interesting portion of the whole structure is the machinery, and the *screw*, by which she is propelled. The latter is on the same principle, but slightly modified, as that invented by Mr. F. P. Smith, of the Patent Ship Propeller Company (who supplied it), and who, some years ago, exhibited it in the Archimedes. The manner in which it is fixed, worked, and speeded, will be seen by the illustrations.

The alphabets and figures are repeated over the same parts of the ship in all the views, so that the same parts in each may be identified.

Fig. 1*. A longitudinal vertical section of the entire vessel, showing the various compartments; and Fig. 2*, a side view.

A B. Surface line of upper deck.

C. Principal promenade saloon; length, 100 feet by 48 at the widest part; height, 7 feet; 24 berths on each side.

D. First class saloon, or dining room; length, 100 feet; greatest width, 50 feet; height, 8 feet.

E. The cargo deck, 65 feet long, by 9 feet high.

F. An iron fresh water tank; length, 40 feet.

G. A room for a coal store, &c.

H. Elevation of engines.

I. Ditto of boiler.

J J. Iron deck over boiler, for cooking apparatus.

K. Fore or second class saloon, 84 feet long, 7 feet 9 inches high.

L. Lower fore saloon, length and height as above; 40 bed places on each side of these saloons.

M. and N. Iron-floored cargo decks.

O. Air chamber from boiler to bulk-head, of the shape of the ship.

P. Officers' berths, &c.

Q. Sailors' mess room.

R. Sailors' berths; *r.* small water tank,

S. Water-closets.

T. Ship's stern-post, through which the screw passes.

U. Shaft from engine to screw.

V. Diagonal stay from the ship's side to the stern-post.

W. Side view of screw stern-post, in which the end of the screw spindle revolves.

X. Keel under the screw, uniting the stern-post to the vessel.

Y. Hollow rudder foot, and of such a thickness as to receive the stern-post, which forms its pivot.

BOILER AND MACHINERY.

	ft.	in.
Boiler (square on plan), about	33	0
Length of fires	6	0
Width of ditto	2	0
Total surface of fire-bar (feet superficial)	281	0
Chimney (diameter)	8	0
Height of ditto about	45	0
Diameter of four cylinders	7	4
Length of main *wrought-iron* shaft	15	9
Diameter at centre for driving-wheel	2	3
Weight in the rough, as from the forge, upwards of 16 tons.		
Diagonal framing for support of shaft, of very hard and strong foreign wood.		
Cranks, thickness at large hole	1	6
Width at the head	3	6
Diameter of large driving-wheel	26	0
Ditto of rigger on screw shaft	6	0
Keel under screw, 12 inches wide on the top face, 9 inches under face, 5 inches thick.		
Screw stern-post, 20 inches across the centre; rudder, 6 feet 6 inches wide at bottom.		
Distance between the stern-posts	11	0
Height of screw, about	15	0

Fig. 1 represents a transverse section of the vessel at the engine-room, with an end view of the machinery.

Fig. 2. (double). A longitudinal section of the vessel, with a vertical section of the boiler, and an elevation of the starboard engines.

Fig. 3. Horizontal sections of the boiler, and general plan of the engines.

Figs. 4 and 5. Outline and section of a cylinder, steam-valves and a foundation-plate.

Fig. 6. Piston-valves to work the valve-cases.

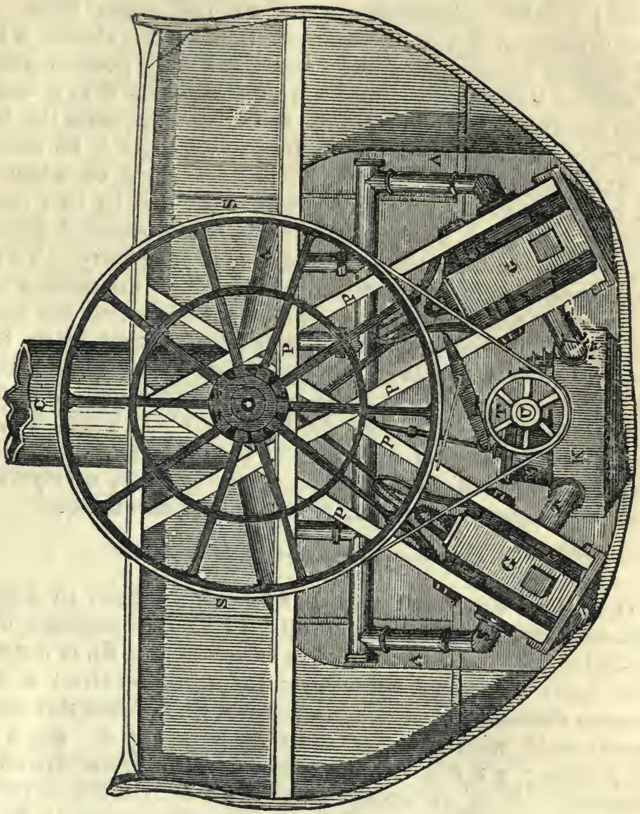


Fig. 1.

THE BOILER.

A A A A represents the outline of the boilers in figs. 1, 2, and 3, which is about 11 yards square in the plan. B B B B is a vertical section through the fires, near the middle of the width, showing the direction of the heated air and flame. *a a*, the furnaces; *b b*, the middle flues; and *c c*, the upper flues. On the boiler plan, in fig. 3, the portion marked *d d* shows a horizontal section through the line *e e* (see fig. 2); the portion marked *f f*, a section through *g g*; and the part marked *h h*, a section through the line at *i i*. Within the boiler, and opposite the holes for the escape of steam to the engines at O, there is an inclined plate fixed to prevent "priming," the *top edge* of which the steam has to pass. The entire boiler is divided by two vertical partitions, *j j* and *k k*, thereby forming three distinct sections, either of which may be put out of use if necessary. To each section there is a sluice, or side-valve, fixed in the casting at D, with its face towards the boiler, the edges of which are planed to form wedges with the points upwards, so that by its being drawn up by the rod, it is at the same time forced hard between the seat frame and inclined brass bars, therefore shutting off the the steam from that section of the boiler. C C C, figs 1, 2, and 3, are an outline, section, and plan of the chimney.

The boiler is furnished with six water gauges, safety-valves, blow-offs, water-valves, and all the usual appurtenances.

THE ENGINES.

D D D D are the steam cylinders, which are four in number. E. fig. 4, piston, and F, piston-rod. G G are sections of the steam-valve cases and side-pipes, in which *m* (fig. 5), is the steam branch from the boiler, containing the throttle-valve; *n* is the expansion slide-valve, working against a fixed plain flat surface, but perforated with holes, as seen at *p* in fig. 4. *q q q q* are brass linings; *r r r* is the eduction passage from cylinder to condenser. H is an escape-valve in the cylinder cover; as also at I for the bottom. J J. is the foundation-plate; K, condensers; M, air-pumps; N, hot well; P P, boiler and bilge-pumps; *s s*, steam-pipes to the engines; *t*, beam for parallel motion; *u u*, guide standards for piston-rod; *v*, connecting-rods to the cranks; *w*, air-pump connecting-rod; P P P P, wood framing for support of upper works; Q, main shaft; R R, cranks; S, main driving-wheel; T, lower pulley; U, shaft leading to screw.

The dimensions of the principal parts are given in the previous page.

The boiler platform is of plate-iron, supported upon ten iron

kelsons, of which the centre ones are 3 feet 3 inches deep. These kelsons are formed, like the floorings, of iron plates placed on edge.

The hull is divided into five distinct compartments, by means of water-tight iron bulkheads.

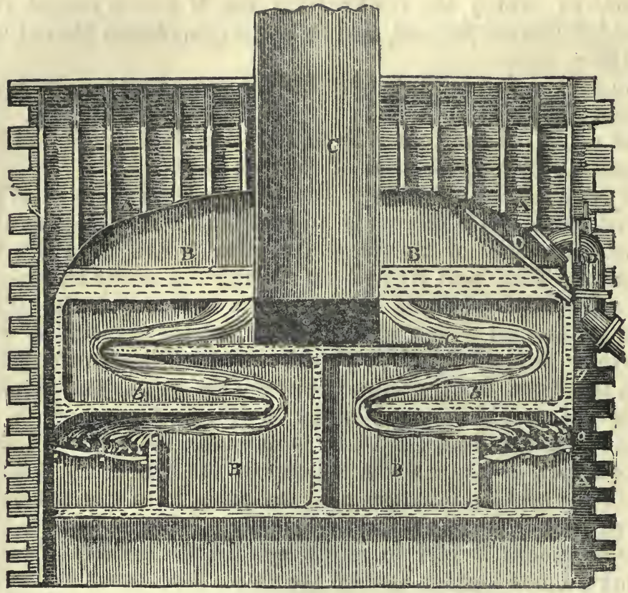
The whole of the materials and workmanship, both of ship and machinery, appear to be of the first order.

On the angle iron beams of the lower decks there is an iron plate of from 2 to 3 feet wide by half-inch thick, running along against each side of the vessel, the edge of which is fitted up against the ribs, and riveted on to the flat angle iron beams. This continuous plate is made of the ordinary boiler plates, united at the end with a jointing fillet "single riveted" to each, and over it are laid the deck planks, to which they are bolted; it being, therefore, firmly secured between the beams and planking, cannot fail to aid very materially in resisting any sudden and partial resistance externally, and to maintain the original form.

The upper, or main deck, is planked longitudinally 3 inches thick in the middle, 6 inches near the sides, from which there is a mass of timber forming the "water ways," increasing from six inches to about 2 feet in depth against the outside planking, forming a curve surface against the ship's side above and below, to admit of which the iron beams are bent down at the ends. The planking of the first saloon deck consists also of longitudinally laid planks, 6 inches wide, 4 inches thick, with "water ways" 10 inches thick at the sides; and, as it lies on the before-mentioned horizontal plates, the projection is all above the surface of the deck. The planking of the third deck runs across the ship, with 6 × 4 inch "water ways," as in that immediately above.

THE MACHINERY AND ENGINES.

The boiler (as shown by the sections) presents a great space of heating surface, and is amply strong for condensing engines. The foundation plate of the engines has a conical depression of about 12 inches, into which the piston dips; this depression fits into the bend of the ship, and is therefore taken advantage of in depressing both faces of the piston, and also dishing the cylinder cover to about eight inches at the centre, thereby affording the connecting rod to be that much larger. The piston is cast with its top and bottom face, arms, and outer ring, in one piece; and for the purpose of fitting in the keys to fasten the rod there are two holes, into one of the spaces between the arms, through which the fitting and fastening is performed, and which holes are then stopped by circular plates, with valve mitre edges, and made fast. The rubbing, or "metallic" surface of the piston, is one



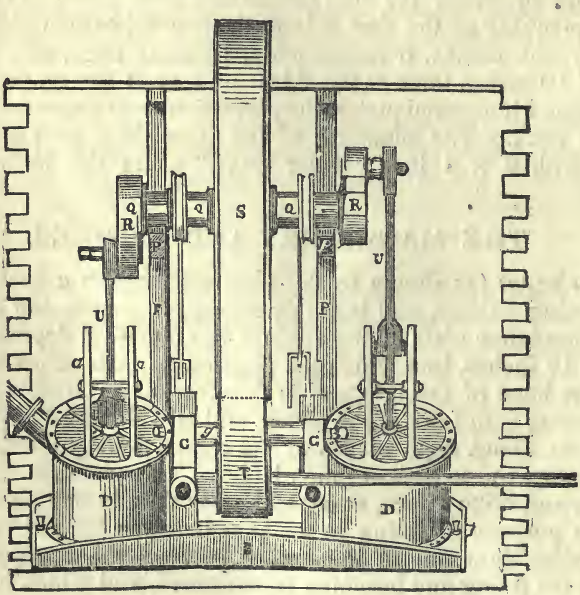
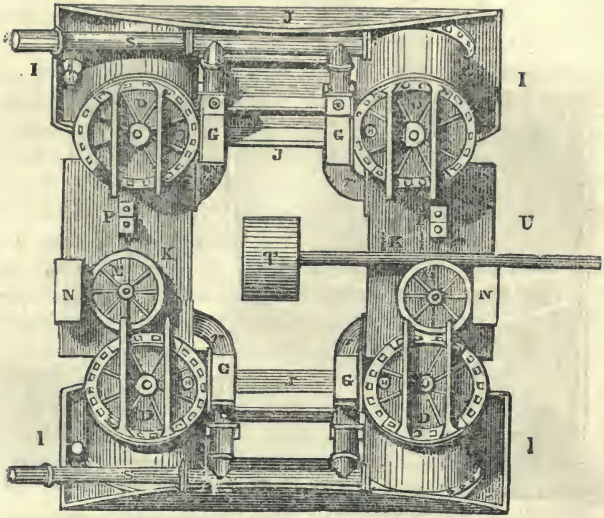


Fig. 2.



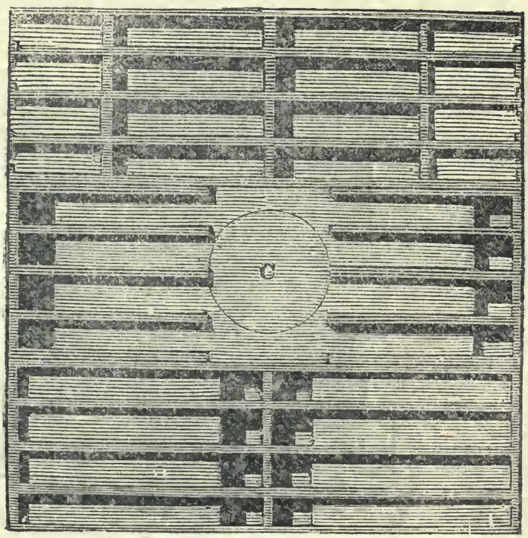


Fig. 3.

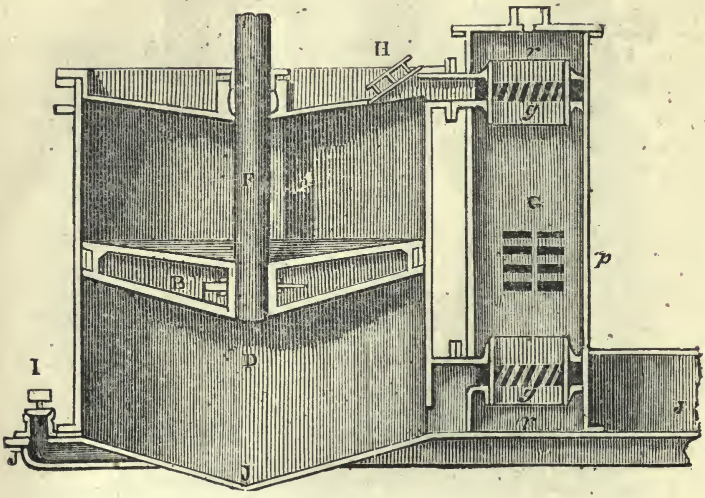


Fig. 4.

Fig. 6.

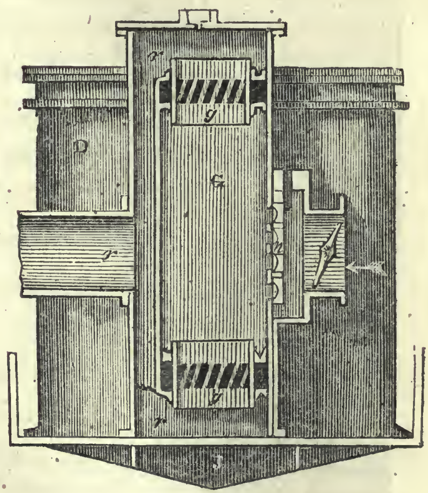


Fig. 5.

ring of cast iron, cut open at one point, with a half-lapped joint, depth seven to eight inches, to be packed behind. The nuts for holding down the screws for the packing ring are turned cylindrical, and inserted into holes of $2\frac{1}{2}$ inches diameter, drilled in the top of the piston. The holes to be expanded by heat, and the nuts inserted cold, so as to be held in by friction, and secured by a tap screw. The shells of the piston valves are brass cylinders with steam openings, as shown by the sections, having a "twist" to render the wear more uniform. The piston valves have a cast iron expanding ring as have the cylinders. These pistons are worked by eccentrics in the usual way, but the "reversing" is effected by an eight-feet spur wheel attached to the eccentric, with an appropriate contrivance to put it into gear.

The *Screw* is of six arms; the diameter is 16 feet, 25 feet pitch, and it is placed near the keel under water. The Spindle that turns it is placed in a stuffing box. On this part of the subject Mr. Hill remarks :—"Allowing the diameter of the Great Britain screw to be 15 feet, the diameter of the circle of effect would be about 12 feet 6 inches circumference; therefore the mechanical constructions, if developed to a straight wedge, would be represented by A B, fig. 9, line of axis; C D, distance passed over by one revolution (13 feet 2 inches); D E, circumference of circle of total effect; and C E, acting face of the screw. The amount of resistance caused by the friction or adhesion of the water on the face of the screw will very much depend on the smoothness of the surface; or, probably, a thin disc of water will be carried round with the screw, and the friction take place amongst the particles of water at some slight distance from the face. F G, fig. 10, shows the divergent lines of the cone of motion communicated to the water, and, if the above premises be correct, it appears to promise a greater effect than has generally been expected, inasmuch as the direction of impact of the screw does not make so great an angle from the line of the axis."

The performances of the Great Britain since this was written have proved the correctness of Mr. Hill's anticipation. He then, too, stated—"It is contended by many nautical men, and some eminent in the profession, that the situation of the propelling force being at the stern will cause the vessel to run very wild in a head wind, and to counteract which the rudder will be in such constant requisition as to cause a considerable loss of power; but *one sound and settled fact* is worth a thousand opinions. Taking all the circumstances into consideration, it does appear that if by the use of *an equal weight of fuel* the duty' performance of the screw be *nearly* equal to that of the paddle wheel, and that the whole of the machinery be so constructed as to be

lasting, and not unpleasant to passengers, it has the merit of being free from serious inconvenience of the paddle-wheel, such as great top-heaviness, opposition of the paddle-boxes to the wind, &c., and possesses these advantages besides, namely, that strength in the upper part of the ship is not required to support machinery, and that the deck is clear—a great comfort to passengers, and of great convenience in management of sails and working the ship."

It has since been proved that the Great Britain does not "run wild in a heavy sea," that she steers with great ease, under sail or steam, and without any loss of power, more than any sailing or other vessel, through the action of the rudder; so that the first point may be considered as settled. As to the advantages of the screw in doing away with the lumbersome paddle-wheels and their bandbox casings or boxes, which destroy the straight sheer of a ship, by giving her a dromedary hump tending to strain her upper works, and form, as it were, "sails" in beam winds, that cannot be reefed—there can be no question. The safety of the screw over the paddle-wheel, whether in collision or contact, or as regards the shot of an enemy, is equally undeniable; for, in both respects, the screw is by far the less vulnerable. Another great advantage of the screw is (supposing it equally efficient with the wheel as a propeller), it possesses in itself a mechanical power or gain (that of the inclined plane or wedge), while the wheel presents, on the contrary, a direct leverage *against* the engine equal to its semi-diameter, or rather to the distance between its centre or shaft and its floats. The beating down of the water by the paddles in the first instance, and the lift or back water in their leaving the surface, involves also a great waste of power, that is not attributable to the screw, which possesses a uniform power of forward propulsion.

Our opinions have so frequently been expressed in favor of iron as a material for ship-building, and especially for steamers, that we do not deem it necessary here to repeat them. Suffice it to say, that we consider a well-built iron ship, with water-tight bulkheads, much safer from foundering, or from wreck, even on a rocky shore, than any wooden vessel, let the builder construct her as he may.

THE CABINS.—(Figs. 11 and 12.)

These last illustrations are *typographical* plans of the main and fore saloons, with the state-rooms, &c., on each side. The Great Britain has 26 state rooms with one bed each, and 113 with two, so that in addition to her crew, officers, firemen, &c., she can accommodate 252 passengers, each of whom can be provided with a single bed, and that without making up a single sofa, or any other temporary convenience.

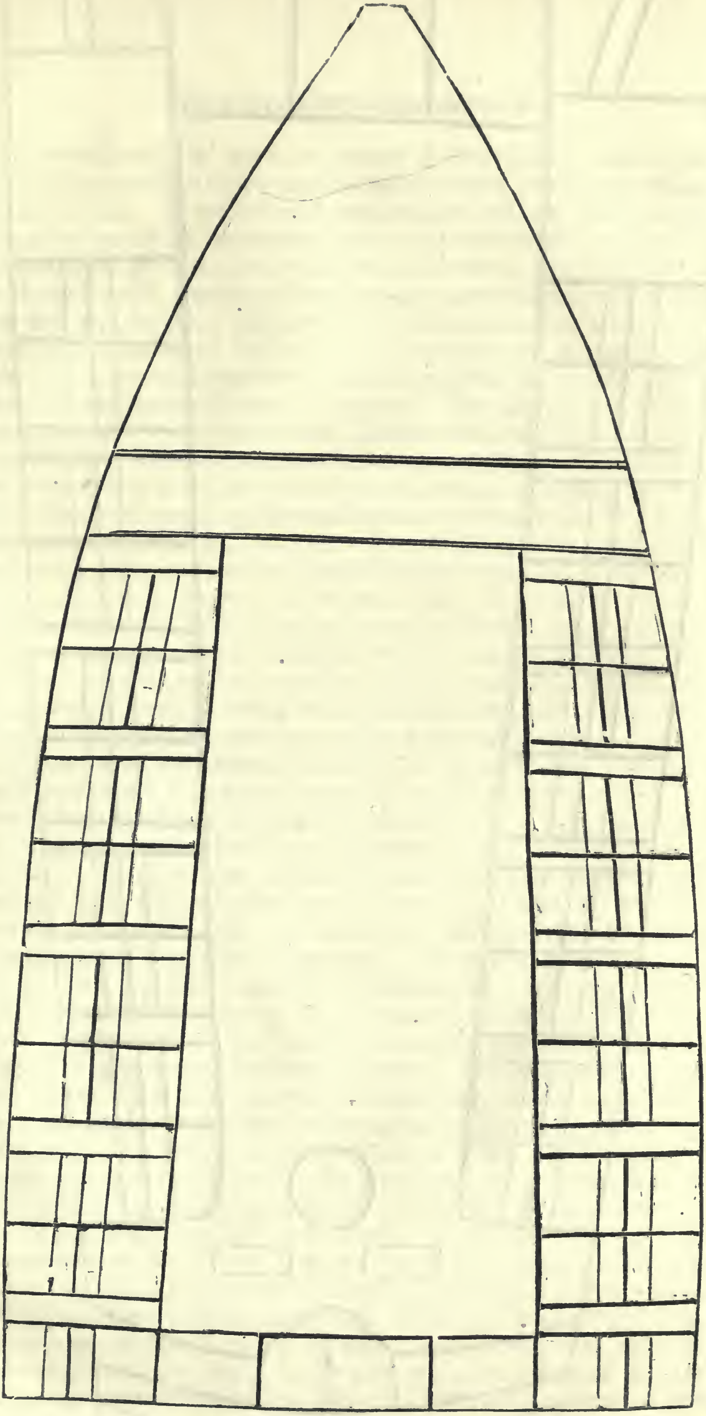


Fig. 11.—Forward Promenade Saloon, State Rooms and Berths.

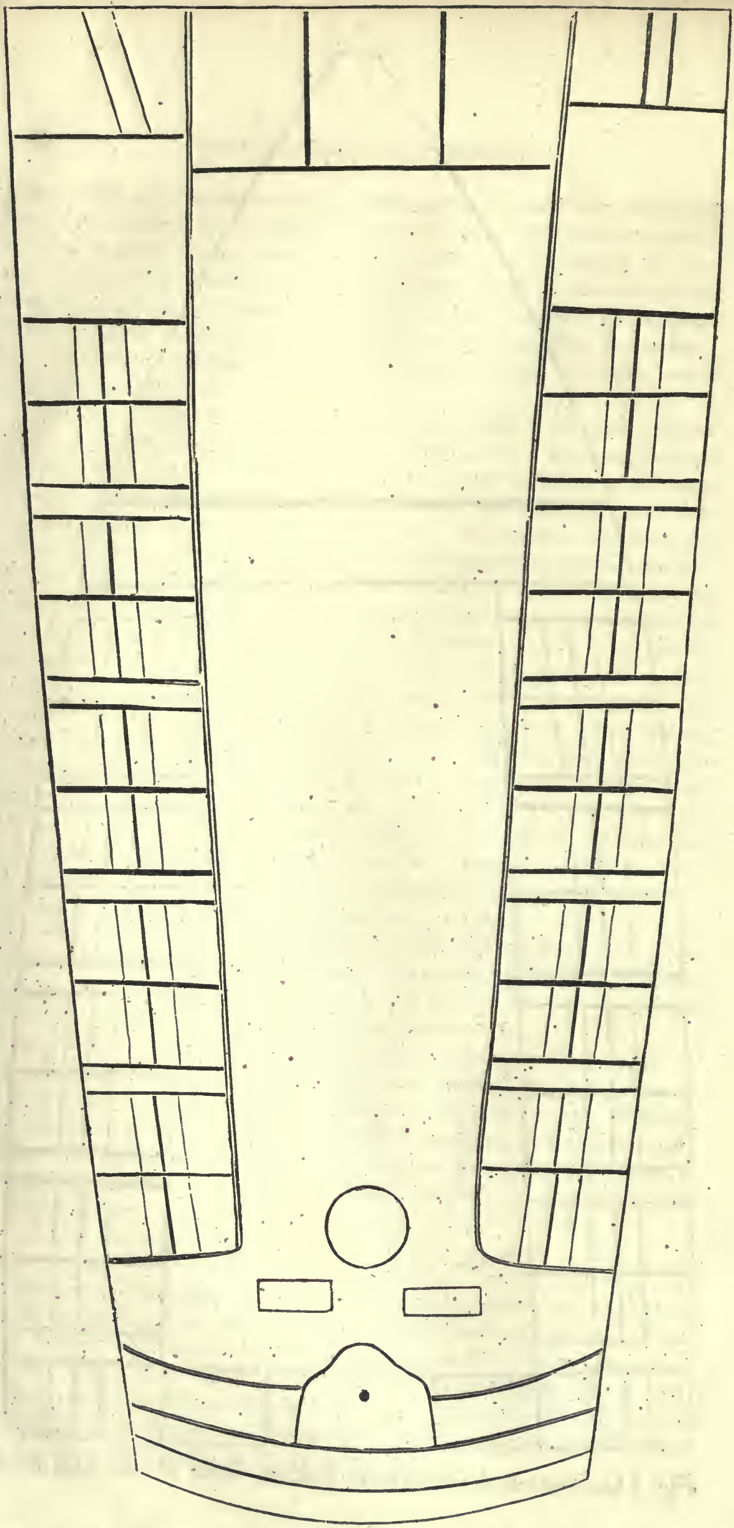


Fig. 12.—After and Principal Promenade Saloon, State Rooms, &c.

The walls of the after or principal promenade saloon are painted in delicate tints; and along the sides are several fixed chairs of oak. A row of well-proportioned pillars, which range down the centre of the promenade, serve the double purpose of ornament to the room and support to the deck. In this saloon, on either side, is a range of exceedingly comfortable state rooms and sleeping berths. About twelve of these on each side of the deck will be reserved for ladies, as they are made to communicate with two commodious ladies' boudoirs, or private sitting rooms, measuring 17 feet by 14 feet. The advantages of this arrangement must be obvious, as ladies who may be indisposed, or in negligé, will be enabled to reach their sleeping berths without there being the slightest necessity for their appearing in public. The frame-work of the staircases communicating from this saloon with the deck, is of iron. The stairs are far more wide and commodious than is generally met with on ship-board. From this promenade you descend into the main or dining saloon, which is 98 feet 6 inches long, by 30 feet wide. This is really a beautiful room. A large sum of money has not been uselessly squandered in procuring for it gaudy decoration, not harmonizing with its uses, but its fittings are alike chaste and elegant. Down the centre are twelve principal columns of white and gold, with ornamental capitals of great beauty. Twelve similar columns also range down the walls on either side. Between these latter and the entrances to the sleeping berths are (on each side of the deck) eight pilasters, in the Arabesque style (of which character the saloon generally partakes), beautifully painted with oriental birds and flowers. On either side are seven doors, which open into as many passages, each of which communicates with four bedrooms. The archways of the several doors are tastefully carved and gilded, and are surmounted with neat medallion heads. Some looking-glasses are so arranged as to reflect the saloon lengthways, at two opposite sides, from which a very pleasing illusion is produced. The walls of this apartment are of a delicate lemon-tinted drab hue, relieved with blue, white and gold. At the stern end are a number of sofas, which range one above the other, nearly up to the stern-lights. At the opposite extremity is a large room for the steward's use. The saloon is fitted with rows of dining-tables, of sufficient capacity to admit of 360 persons sitting down to dinner at one time, with perfect convenience and comfort. On each side the forward promenade saloon (on plan 11) there are 36 berths or sleeping places, and in the saloon below it 30 in each side, making in all, forward, 132. To the state-rooms there are passages leading from the saloons, and running athwart the ship, as shown in the plans 11 and 12.

In the forecastle are berths, 36 in number, for a portion of the

crew. The iron ribs, and the mode in which the ship is riveted, can be well inspected from this apartment.

ADDITIONAL MEMORANDA.

The length of the Great Britain from her figure-head to her taffrail being 322 feet, she is 60 or 70 feet longer than a line-of-battle ship. All the masts, except the main-mast, are affixed to the deck by iron joints, and in the event of a strong head wind can be lowered like the mast of a canal boat. The diameter of the mainmast below is 34 inches, and its height above the level of the deck 74 feet. The main topmast is 55 feet long. Diameter of foremast 19 inches, height 68 feet. The other masts proportionate.

Eight walks round the principal deck are about equal to a mile in length.

In the construction of the hull and engines the enormous quantity of 1500 tons of iron have been used.

The rigging is of iron wire rope, offering less resistance in going to windward than hemp, which would require greater thickness for equal strength.

The engines weigh 340 tons.

The main shaft is 28 inches in diameter in the centre, and 24 inches in the bearings; in the rough, before turned, it weighed 16 tons. It has been lightened by a hole of 10 inches diameter bored through it. A stream of cold water passes through the cranks and this hole when the engines are at work.

The screw shaft is in one long and two short or coupling parts. The part next the engine, solid, 28 feet by 16 inches diameter. The hollow intermediate shaft 65 feet, by 2 feet 8 inches diameter. The screw part is 25 feet 6 inches, and also 16 inches diameter. The total length is 130 feet, and it weighs altogether 38 tons.

The entire merit of employing the screw as an instrument for propelling vessels is due to Mr. F. P. Smith, in conjunction with that small body of gentlemen who built the Archimedes. This was a handsome, rakish craft, with fine lines, but the machinery that was contrived for conveying motion to the screw proved so objectionable, from the intolerable noise it made, that it discouraged for a time further attempts on this plan. Nevertheless the vessel made good way, and those who witnessed her performances, and whose opinions, either as naval or scientific authorities, were entitled to respect, almost unanimously satisfied themselves that the screw was destined sooner or later to supersede the paddle-wheel, and many so expressed themselves in their letters to Captain Chappell, R. N. Mr. Brunel introduced broad leather

straps in the Rattler, for the purpose of avoiding the noise caused by cog-wheels, and they work well; but in the Great Britain the chains, for the same object, although weighing seven tons, work without the slightest noise.

The displacement of the Great Britain will be rather less than 3000 tons when loaded, with 1200 tons of coal on board; while the displacement of a first-rate, with all stores on board, is better than 4500 tons, although the former is more than a third the longer ship. The form of the bottom, and the difference of ten feet in the draught of water (the one drawing sixteen feet, the other five or six-and-twenty), and the finer lines, cause this great difference in displacement, and, consequently, of the midship section. The Great Britain's midship section is, from the same cause, less than that of a 52 gun frigate, consequently, with the same quantity of canvas, the former should sail faster than the latter, even if their lines approached to similarity; but with the Great Britain's lines, more than one hundred feet longer than the frigate, and with equal stability (of which there is no kind of doubt), the speed in sailing alone should be much beyond that of the frigate, save when the winds are light, and the lofty sails of the frigate tell.

REMARKS UPON THE CONSTRUCTION, &c., OF THE STEAM-SHIP GREAT BRITAIN: AND UPON THE *Comparative merits of Iron and Wood as Materials for Ship-Building.*

BY

CAPT. CLAXTON, R. N.,

A DIRECTOR OF THE GREAT WESTERN STEAM-SHIP COMPANY.

Ten iron sleepers run from the engine-room, gradually diminishing in number, to the fore-end of the ship and under the boilers, the platform of which they support; in midships they are 3 feet 3 inches in depth, supported by angle irons in the form of inverted arches, and a short distance from each other.

From the ship's bottom to the upper deck, runs on either side, for the whole length of the engines and boiler space, a strong iron partition forming below the coal bunkers; and above, the servants' accommodations on one side, engineers' cabin and stokers' accommodations on the other, besides 26 water-closets.

She has six masts, fitted with iron rigging, adopted in consequence of

its offering two-thirds less resistance than hemp, a great point going head to wind. It was wished that five should have been the complement, but there was some difficulty in adjusting that number, and the alternative was either four or six. Economy of labor is a principle which has, in a great degree, affected the mode of rigging both the GREAT WESTERN and the GREAT BRITAIN. Nothing is so difficult to handle, under a variety of circumstances, as the sails of a steamer, unless the engine be stopped, which can never be allowed in Atlantic steaming, where onwards, and for ever onwards, is the rule. The greater the number of masts, the more handy the sails, and the smaller the number of seamen required to handle them. If these ships had been rigged as ships ordinarily are, the former would require a crew of more than 100 seamen, and the latter that of a large frigate. Divided, as the canvass is, and reduced, the former only requires 20 seamen before the mast, while 30 are enough for the latter. In the Great Britain there is in fact but one sail, the square mainsail, which, under any circumstances, can require all hands to furl it. Five masts of the six are hinged for lowering, when, in the Captain's judgment, contrary gales shall appear to have set in, as the westerlies do at certain seasons of the year, prevailing for months in the Atlantic. To a seaman's eye they have a look of insecurity; but if the strain which a fixed mast will stand is compensated by additional shrouds and stays, either in strength or quantity, the same end is attained. The after masts could not be stepped in the ordinary manner, on account of the space occupied by the screw-shaft. In theory, the principle of lowering is evidently right, because a steam-ship's masts and rigging going head to wind offer more resistance than the hull out of water, and there seems no reason to fear the result in practice.

The plain sails of a fifty-two-gun frigate, i. e. without counting royals, staysails, and steering sails, number something short of 5000 yards of canvass, and the plain sails, i. e. omitting the steering sails, &c., of the Great Britain, amount to 4943 yards, or, in other words, they are alike in quantity. There are more points of sailing in which the centre of effort of the frigate's or square rigged ship's canvass will tell better, but there are some in which the low canvass of the steamer will have the advantage, and no *steamer* has any business with lofty spars or flying kites. If circumstances should bring the Great Britain to canvass alone, as her motive power, she will do as well or better than her neighbours, although the screw will stop her way perhaps fifteen per cent. In such an emergency the Captain would disconnect it, and it would revolve then in the proportion due to the ship's way, or not impede her as if it were a fixture.

She carries four large life-boats of iron, and two boats of wood, in the davits, and one large life-boat on deck; they are built according to a patent taken out by Mr. Guppy, and are capable of carrying 400 people.

The Great Britain was built by the same company which built the Great Western, the first ship regularly laid down, launched, equipped, and sent to sea, for the purpose of establishing a steam line between America and England.

No sooner had the Great Western, in contempt of the elaborate and

confident assertions of philosophers—at the meeting of the British Association in 1836, at Bristol—that it would be impossible for her to succeed in crossing the Atlantic—performed her voyage with the greatest ease to New York and back, than the Directors found that steam-ships of larger dimensions would offer better chances of remuneration. Guided again by the suggestions of that superior man, who had before emboldened them to build the Great Western, they now determined that their second ship should be built of iron instead of wood, and subsequently propelled by the screw instead of the paddle-wheel; and the Great Britain steam-ship as she now is, is the stupendous progeny of the genius of Mr. Brunel, and of their faith in it. But the machinery which this great engineer contemplated was so vast, that the Directors sought in vain to make a contract for it; they resolved, therefore, that, upon the death of Mr. Humphries, whose trunk engine it was originally intended to apply, it should be constructed at their own works, and, under the advice of Mr. Brunel, confided the management of the construction to Mr. Guppy, who had previously been one of the Directors. Thus the keel of the ship was laid in July, 1839, and, under Mr. Guppy's masterly superintendence, she was so far finished as to be launched, in the presence of H. R. H. Prince Albert, on the 19th July, 1843.

The ship's dimensions were adapted for a free passage through the locks of the Bristol Dock Company when light; but for the convenience of the Company and the trade of the port, as much as on the score of economy, it was deemed advisable to put the engines on board before she left the works. This measure rendered it imperative that a certain degree of temporary accommodation, in widening the top of the locks, should be afforded. The consequent negotiations led to her imprisonment for a few months. The Directors of the Dock Company having at length cheerfully and unanimously afforded all the facilities asked, she was on the 12th of December taken down the Avon and the Bristol Channel on her first trial trip.

Mr. Brunel and many other scientific gentlemen were present at this trial, and its results completely verified, nay, exceeded, all the bold anticipations of the engineers. Indeed, Mr. Guppy, during the four years of extraordinary labour which he was employing in bringing to a successful issue the recommendations of Mr. Brunel and the instructions of the Directors, had gathered that confidence in the sciences of iron ship building and marine engineering, that he had given the lines for the iron ship *William Cobden*, which was built at Liverpool, and which has since, unfortunately for herself, afforded such ample proof of his skill; for, being overloaded with a large cargo of iron and *limber kentledge besides*, she lost her masts in a heavy gale off Cape Clear. She managed, nevertheless, under jury masts, to claw off the shore, where she was embayed, when all hope seemed over; and, according to the Captain's report, the speed of this ship is greater than that of any known, even among ships of war.

The superiority of iron over wood-built vessels is so far admitted as to render it almost unnecessary, at the present day, to mention the reasons which induced the Directors to give it the preference; but five years ago, when they boldly decided to build their ship of iron, the case was

different. The Directors then instituted the most searching inquiries, without experience, and with scarcely theory to guide them. The writer of these pages, then Managing Director, made several passages in the Rainbow, and in other iron vessels, accompanied by Mr. Paterson, the builder of the Great Western, who afterwards furnished the lines for the Great Britain, for the purpose of testing their sea-going qualities, trying errors and variations of compasses, making investigations respecting oxidation, fouling of bottoms, buoyancy and stability under canvass. It became manifest that iron would afford greater strength, greater buoyancy, and more capacity at less expense than wood. In capacity alone, for instance, the Great Britain gains considerably more than 600 tons. To make this clear to every one, it is necessary to suppose the angle-irons or ribs, the shelves, &c., &c., rolled out and added to the thickness of the plates forming her sides—when an average thickness of two feet of timber is represented by an average thickness of $2\frac{1}{2}$ inches of iron, with far better ties, more compact framework, and far greater strength altogether than wood can, under any circumstances, afford. It was shown, likewise, that dry-rot—that plague of wooden ships, as Mr. Grantham calls it in his recent publication—would be wholly avoided with iron; that there would be freedom from vermin, and from the stench and unhealthy consequences of bilge water.

The Directors were assured that the compasses could be easily adjusted; that with care oxidation could be guarded against, provided all parts of the ship should be examined or watched; that scarce a tithe of the expenditure required for keeping a wooden ship in repair was likely to ensue in iron; that, when necessary, repairs could be more quickly and easily effected; that there would be neither stripping of copper, sheathing, nor caulking; that nothing was to be apprehended from lightning, which, in wood-built ships, is so frequently attended with fatal consequences—nor, comparatively speaking, from fire, one of its effects; that finer lines, with equal strength, were attainable, and, of course, greater speed; that they would not be so easily wrecked, whether striking on a rock or beating over sandbanks; that they would run no risks from starting butts—were stiff under canvass; and that the only point in which inferiority might be apprehended was in the fouling of the bottom; but that if means for providing against or removing this within the tropics, should prove incomplete, a steamer always rapidly progressing while at sea, and whose ports will be in the high northern latitudes of England and New York, where sea animalculæ abound but slightly, would have nothing to fear even on this point.

An elaborate report, setting forth these results, of a most laborious inquiry, was laid before the Board, and upon the strength of it, but still more upon the recommendation of Messrs. Brunel and Guppy, the Directors resolved to build their ship of iron. Since this determinatiou was acted upon, several able pamphlets and papers have been published, advocating iron instead of wood for ship building; the best of which is that by Mr. Grantham, of Liverpool, with remarks by Messrs. Fairbairn, Creuse, and other eminent gentlemen. All are quite conclusive in the most essential points as to the superiority of iron. The Directors had none of these lights to guide them; they placed confidence in

their advisers, and came to a decision upon facts, and reasonings from facts, to which all that has been since published has added nothing new, except the confirmative results of practice while their Leviathan has been under the hands of the mechanics.

The Great Britain is built with lapped joints in preference to flush, the first system adopted in iron ship building, representing carvel-built ships. The lapped joint is the method employed for clinch or clinker-built vessels. Trials were made at the Company's Works of the comparative strength of the two methods, and the lapped joint was stronger by one-fifth of the whole strength. It is obvious that for the purpose of resisting lateral pressure or blows of the sea, on the broadside, it must be better than the flush system, where all the strain must be thrown upon the ribs, beams, and decks, the latter horizontally; while, with the over-lapping joint, in addition to *that* resistance, the plates themselves bear against and assist each other in resisting a pressure great in proportion to the length of a vessel. In pitching or dropping, each lap resists a little, and the combined resistance of as many edges as in heavy weather may meet the water would be equal to that of a flat surface of eight or nine inches on each side of the bow or quarter. In flush jointing, the butt plates inside for receiving rivets would, for double rivetting, have to be twice the depth of the lap of the joint in the other system, consequently a great additional quantity of iron would be required for the whole length of each seam, or in the Great Britain about 18,000 feet of iron, 6 in. by $\frac{3}{4}$, and double the number of rivets, an addition in weight of nearly 100 tons. Flush rivetting, however, has its advocates, and one advantage over the other, which is that each plate rests on its fellow, like the planks of a ship, and not upon the rivets; but this again is more than counterbalanced by the facilities for caulking. As to the difference in sailing, often quoted, no importance should be attached to the slight difference in friction in iron ships, where the laps are few and far between; and if experience be a test, clinker-built cutters and yachts, Deal boats, &c., &c., are as fast as others, and as good sea boats.

Another great advantage has not been noticed by writers generally, if at all, although in the Report of the Directors, in 1838, already alluded to, it is strongly urged, viz., the comparative safety in ice. Not a year passes that dozens of ships are not sunk from striking against small floes of ice, which float so nearly level with the water as not to be always visible in the night. Iron sailing vessels, and steamers fitted with screws, may fearlessly keep up their speed and continue on their course when it would be rash to venture wood-built ships or paddle-wheels; the former have, in point of fact, only to keep clear of downright icebergs and closely-packed ice, while the latter run some risk with a piece of the size of a jolly boat.

The sides of the Great Britain were scarcely visible over the walls of the yard in which she was building, when naval officers, ship-builders, engineers, and philosophers from all countries began to seek admittance, and many have been the papers which in most languages have been written on the comparative merits of iron and wood as a material for ship building, which would not probably have seen the light, had not a scale of dimensions been decided upon, which may create astonishment at the present moment, but which will probably excite no more

wonder in a few years than the size of the Great Western does at present. Yet it is still fresh in the memory of all who know anything on these subjects, that the nautical and philosophical prophets who concerned themselves in 1836 and 1837 with the then future fortunes of that great pilot of Atlantic steaming, the Great Western, predicted, with undoubting assurance, "that from her extreme length *she would break her back*—that it would be impossible for her to steam so much as 2,000 miles;" and they denounced the gross temerity and ignorance of her builders. In obstinate defiance of the foreknowledge of these gentlemen, and notwithstanding the ignorance and rashness of her builders, she has now steamed for seven years—once, on a single stretch, accomplishing not far short of 4,000 miles—and, judging from a recent report of one of the Government Surveyors, and from frequent reports of the Surveyor-General, at Lloyd's, she is at this moment *as sound in material, and as perfect in form*, as on the day she was launched. Those, therefore, who are interested in the Great Britain must naturally augur the best as to *her* future fate, enlightened by the experience of the past, from finding that she too is heralded to the deep by the very same judges, with prophecies as ominous as those which harbingered her elder sister across the Atlantic; and knowing, as they do, that her builders are not now less ignorant and rash than when the Great Western was given to the ocean, they may tranquilly hope that she will not be less successful.

Timber being cheaper, and wages lower, on the Continent than in England, and the former plentiful in America, the merchant ships of several nations have an advantage over those of England, and of course obtain a preference in freights. "The Wooden Walls of Old England" are very dear to all of us, but the Iron Walls may earn a name replete with national glory; and at any rate iron in the merchant service would give us for a very long period the advantage over the maritime nations of the world.

Mr. Creuze's opinion is clear and distinct, that iron should supersede wood in her Majesty's ships of the largest size, and if the tendency to fouling under water can be got over, there cannot be a question that he is right. Mr. Grantham is of the same opinion, and his reasoning is sound on most points—on all, indeed, except guarding against a point blank fair-hitting round or half shot or a shell—and on this point it is a question whether it would be wise to add anything to the inside for this purpose, as the skin or inner side of the plates should never be hidden. Let the shot come in, it will carry no splinters, but make a jagged hole, whose jagged parts may almost be beat back; and as to stopping the hole, if under water, a bundle of oakum or a large swab will be almost enough, if lowered from the outside over it; but it requires no great conjuror to adapt appliances to be placed, as handily, and as thickly, and more efficient in themselves, than the wooden plugs which line our men-of-war's orlop wings, and many must be the shot-holes that the pumps of large engines will not beat. At a slight angle, shots will glance off, simply making a dent, which a man from the inside may make fair again when the action is over; and as to repairing shot-holes above water, the ship's smith and engineers would do that as effectually and well at sea as in port. If a ship with a bow like the Great Britain's were fired at from morning till night by the Excellent, Sir Thomas Hastings, end on,

it is probable that neither shot nor shell would make any other impression than a slight dent. The same might be said of a round stern, and indeed of the Great Britain's, from the cabin deck downwards.

Much has been said respecting our steam navy, and a good deal of wonder has been expressed that iron has not been adopted. Several large iron steamboats have been contracted for by the present Lords of the Admiralty; one of large dimensions by Mr. Laird, of Birkenhead, whose performances in iron have won for him an imperishable name, is in a forward state. Tenders are likewise in for several more steam-frigates and sloops; but it does appear extraordinary that the paddle, after the performances of her Majesty's ship Rattler, should be persisted in by Trans-Atlantic Companies. It was under Lord Minto's administration that a copy of Mr. Brunel's report to the Directors of the Great Western Steam-Ship Company was asked for, and furnished by that gentleman's permission, and the Rattler was subsequently ordered to be built, he having, at that Noble Lord's request, undertaken to order the machinery, and to report as umpire upon screws. After several years' waiting, and many experiments, with different modifications of screws, she has proved, with Mr. Smith's, to make a knot an hour more than any paddle-wheel steamer of the same tonnage and power in the service. This, after a battle against prejudice of some duration, is at last admitted, and it would seem that simultaneously it ought to be admitted that the screw is a better propeller than the paddle-wheel, "quoad" propulsion only; as to all other points of comparison between them, the superiority of the screw is incontestable, and the longer the voyage the more conspicuously will this be made manifest. The more prominent points of superiority are:—1st.—The facility afforded in carrying canvass, inclination or heeling over not affecting the motive power of the propeller; while in a paddle-wheel craft, if sail be carried to any extent, with the wind anywhere not right aft or on the quarter, the power of one wheel is exerted on air only, while the other is to a great extent rendered nugatory by too great immersion, in spite of the dangerous tram trimming chain lockers, to say nothing of the unequal strain upon the engines. 2nd.—It can only be in the highest seas that the screw even partially quits the water, and then only for a few seconds at rare intervals,* while with paddles the hollow of the seas constantly leaves both wheels exposed, and if the throttling were not attended to, the most serious consequences would result. 3rd.—The breadth of beam in going into docks and basins. As a paddle-wheel steam ship, the Great Britain's extreme beam, *i. e.* from outside to outside the paddle-boxes, would have been about 80 feet, instead of 51. 4th.—The diminished chances from collisions at sea, where the paddle-wheels and houses constantly suffer. 5th.—The difference of resistance to the wind, the paddle-boxes and their appendages creating nearly one half of the whole resistance of the body, to say nothing of the paddle-box, boats, and the attendant tons of iron-work in such ships as have them. 6th.—The ease with which sail may be carried, and the difference in effect between the two systems, if from damaged machinery it becomes necessary to disconnect, and let the propellers revolve; and

* This has been well ascertained by Mr. Brunel's experiments, which embraced observations on the rudder of the Great Western on many voyages.

by no means the least advantage is the getting rid of the *top* weight of frames, shafts, wheels, &c., &c., which are all represented by shafting below the centre of gravity, acting really as so much ballast, in all screw ships; and lastly, the comparative security from the shot of an enemy.

If the Rattler's bow and run had been finer, as, without affecting her warlike qualities, they might have been, she would have gone much faster. She is very full, and throws a five or six feet wave before her. There is no reason why, under water, Her Majesty's steam ships should not be as fine as the Great Britain, if built of iron, and approaching it as far as due strength of that material admits, if of wood, the capacity gained by fulness of bow and run being so to be attained, that they should not be retarded by a mountain wave generated by themselves. The Polyphemus, whose speed was tested, and whose power is the same as the Rattler, appears to have a much finer looking bow, and certainly did not throw so high a wave before her as the Rattler does when going at similar speed. The Great Britain sends no wave before her, and no well designed steam-ship should.

For several successive years hopes were entertained that the experiments in the Rattler would enable the engineers of the Great Britain to arrive at the best conclusions, both as to the number of arms and the best pitch of the screw; but the ship progressing toward completion, and the Rattler not appearing in the field, Mr. Brunel was urged by the Directors to come to some decision, in order that a screw might be put in hand, and the one now adopted is the result. As far as it has been tried, it is an excellent propeller; but there is no doubt that a little more delay would have produced one of fewer arms and more pitch; and still better results may be expected from the spare screw which has been ordered.

The Great Britain is divided into compartments to each of which the engine-pumps, by the means of pipes and cocks, can be applied. The water-tight divisions of each compartment add greatly to the strength of the ship, either as struts or ties. All steamers, whether on the score of humanity, or for the preservation of property, ought to be so divided; for if a vessel be divided into five or six compartments, and any one of them should from accident fill, her buoyancy would only be slightly affected. If two compartments filled, and those two were not at the extremes, the extreme compartments would still keep her afloat. If two consecutive compartments, either forward or aft, filled, it is certain if she went down head or stern foremost, that she would be some time about it, long enough, probably, to give time for all the boats to be got in readiness. The celebrated Nemesis struck on the English Stones, in the Bristol Channel, going nine or ten knots; she slid off, after making such a slit in a plate in the forward compartment as filled it. She steamed several hours with the compartment full, until she obtained additional pumps in Mount's Bay, with which the space was pumped out, and the leak stopped. At Portsmouth she was examined, and drawings of the damage made by an employé of our Company; she was repaired in a few hours, at an expense of about £30, and then started for China. The Brigand, a large iron steamer, which had been trading between Liverpool and Bristol, struck on sunken rocks off the Scilly Islands, filled a forward compartment, and had some part of her paddle-

wheel forced so far into the engine-room as to damage the plates, and fill that part also. She remained afloat in consequence of the remaining compartments, long enough to enable the crew to save themselves and their kits comfortably, and then went down in deep water. The Wye, trading between Bristol and Chepstow, was cut down more than a foot below the water-line by one of the Irish steamers, her stem having gone into the little Wye as far as the forward companion; she continued her voyage, and landed all her passengers as safely, but not quite as fast, as if nothing had happened; in her case, it was the foremost compartment that filled. The Sylph, although a slight vessel and of wood, had compartments; the two foremost filled, but the after one kept her long enough afloat to enable all who were not killed or injured to effect their escape. The case of the Vanguard iron steamer, which for ten days was exposed to heavy breakers, on the rocks in White's Bay, near Cork, may also be mentioned, both as a proof of the strength of iron, and of the value of compartments.

Of the strength of iron ships—of cases where they have been hung up by their extreme ends—of others, where the ends have been unsupported, without injury or deflection—many examples might be enumerated; while, on the other hand, there are few such as the Nemesis, the Elberfelt, and one or two others, where, from the sheer want of strength and proper precautions—from too great confidence in the iron, when but little stouter than tin plates—they have yielded. The Elberfelt was a Rhine boat, drawing less than two feet of water. She was caught in a gale where she ought never to have ventured. If the water-ways are not sufficiently strong, or if they are not supported by shelves or stringers—or if they are cut through in the middle for paddle-beams, and if vessels so weakened are suspended half or a third of their length, they must yield. Since these vessels got into scrapes, iron vessels are generally more strongly built; but boats built for rivers only have no business at sea.

Claimants, in the form of patentees, began to make their appearance, when the power of the first screw was proved; but when it became known that Mr. Brunel recommended its adoption in the Great Britain, several of them commenced active operations. It seems a pity that the mere recital of a description of a patent should be sufficient to secure to its author *all* the benefits, or that something should not be reserved for those who work out the useful inventions even of others, and, as it were, prove what they either lack the means or the courage to prove themselves.

Whatever may be the results of the trials pending or likely to follow in the wake of the Great Britain's well-doing, a commensurate national reward is due to that Company whose courage and energy originated such grand enterprises, and a gratuity of at least an equal amount to Mr Smith, provided the advantages keep pace with the anticipations of himself and his supporters.

No sooner was the problem of steaming across the Atlantic practically solved by the Great Western Steam-ship Company, than Government advertised for tenders to carry her Majesty's mails, and at this moment nearly half a million is annually paid to the enterprising companies who succeeded in obtaining contracts, and who are all ably per-

forming the service. Among others, tenders were sent in by this Company for the Halifax line, but although at about half the sum paid last year (£90,000) for twenty voyages (the first tender only naming twelve voyages per annum), and although we had the merit of showing the way, we were unsuccessful, and our fortunate competitors are paid as near as may be the exact sum per voyage which is required to cover the expenses of the Great Western out and home, viz., £4500, leaving, if the case were hers, a profit varying between 5 and £10,000 per voyage. Perhaps now that the Company has placed a second wonder on the waters, the tide may change in their favor, upon her success, and some notice may be taken of the benefits which, through their private enterprise, England has been the means of conferring on distant quarters of the globe and on herself, and, to use the words of Mr. Grantham, in his clever work, that, by a well-deserved grant, " one of the greatest triumphs of modern genius, one of the most surprising and gratifying results of scientific skill that the world ever witnessed, may no longer be an injury and a loss to those who achieved it."